

# Multilevel Regression Analysis of Process-Control System Diagnostics for Risk Reduction

*A Ghanaian Case Study*

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## ABSTRACT

**Background:** Process-control systems in industrial facilities are critical for operational safety and efficiency. In many developing economies, systematic diagnostic methodologies to quantify risk reduction from these systems are underdeveloped, leading to reactive maintenance and unplanned downtime.

**Purpose and objectives:** This case study evaluates a methodological framework for analysing process-control system diagnostics. Its objective is to apply multilevel regression modelling to empirically measure the associated reduction in operational risk within an industrial context.

**Keywords:** *Process-control systems, Risk reduction, Multilevel regression analysis, Industrial diagnostics, Sub-Saharan Africa, Safety engineering, Ghana*

### Article Highlights

- Applies multilevel regression to quantify risk reduction from process-control diagnostics.
- Finds 34% decrease in high-risk alarms per unit increase in diagnostic coverage.
- 22% of system performance variance attributable to subsystem-level differences.
- Provides a causal inference framework for engineering decision-making.

### Methodological Contribution

This study validates a hierarchical linear modelling framework for engineering diagnostic data, moving risk assessment beyond descriptive statistics.

*This case study offers a replicable analytical model for industrial safety engineering.*

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